<u>**Freeport-McMoRan Chino Mines Company – Administrative Order on Consent**</u>
<u>**Response to New Mexico Environment Department Comments dated June 24, 2011**</u>
<u>**Draft Feasibility Study (FS) Proposal for the Smelter/Tailing Soils Investigation Unit**</u>
<u>**August 11, 2011**</u>

This document presents Freeport-McMoRan Chino Mines Company's (Chino's) response to comments from the New Mexico Environment Department (NMED) on the Draft Feasibility Study (FS) Proposal for the Smelter/Tailing Soils Investigation Unit (STS IU) dated May 5, 2011. The comments were received from the NMED in a letter dated June 24, 2011. The draft FS proposal was prepared in accordance with the Scope of Work associated with the Administrative Order on Consent (AOC) between Chino and the NMED. The FS Proposal has been revised to address NMED comments, and resubmitted with this response document. This document is organized to present a response to each comment received from NMED. Comments from NMED's June 24, 2011 letter are reproduced below in bold text, followed by Chino's response to each comment in italics.

Chino takes this opportunity to note, concerning the on-going surface water studies that are in support of the FS, that Chino is considering NMED's letter disapproving Chino's proposal for a Use Attainability Analysis (UAA) for stock tanks within the STSIU. Chino reserves the right to amend the FS Workplan to consider additional alternatives or approaches to address stock tanks as part of its response to NMED's disapproval letter dated June 30, 2011.

Specific Comments and Reponses:

1. **TABLE OF CONTENTS: the subsections of Section 5.7 are incorrectly numbered and do not correspond to the order presented in the bullets of Section 5.7. Please revise.**

   Response: Comment noted and change will be made.

2. **GLOSSARY: please add OAT and NDVI.**

   Response: The glossary has been updated to include: OAT – Observed Apparent Trend and NDVI – Normalized Difference Vegetation Index.

3. **EXECUTIVE SUMMARY: please revise the last sentence of the first paragraph to read "The data generated ... remedial ~~action~~ *alternatives*, and the data ... ."**

   Response: Comment noted and change will be made.

4. **EXECUTIVE SUMMARY: please revise the last sentence of the second paragraph to read "Final remediation goals will be determined ~~when the remedy is selected~~ *in the Record of Decision*.**

   Response: Comment noted and change will be made.

5. **EXECUTIVE SUMMARY, Surface Soil: please revise the technology list of bullets to indicate NO ACTION as one alternative and *Monitoring* as the second alternative. Also, revise Table 5-1. Table still needs revision.**

   Response: Comment noted and change will be made.

6. **EXECUTIVE SUMMARY, Surface Water: please revise the second sentence of the first paragraph to read "These drainages are ~~generally~~ *commonly* considered ... occurring ~~only~~ during ... ."**

   Response: Comment noted and change will be made.

7. **Text will be revised. EXECUTIVE SUMMARY, Surface Water: please add a statement regarding the persistent pools that exist in some of these drainages.**

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Response: *The first paragraph will be updated to include the following text – "Other than these drainages, the remaining surface water bodies present in the STSIU are stock watering tanks and a small number of persistent pools in some of the STSIU drainages. Chino submitted a work plan to conduct a Hydrology Protocol completed in June 2011and the results will be incorporated into the FS."*

8. **EXECUTIVE SUMMARY, Surface Water: please correct the spelling of the last word in the fourth sentence of the first paragraph.**

   Response: Comment noted and change will be made.

9. **EXECUTIVE SUMMARY, Surface Water: please revise the last sentence of the first paragraph to read "There are ~~about~~ *more than* 20 small to ~~medium~~ *large* sized ... ."**

   Response: Comment noted and change will be made.

10. **EXECUTIVE SUMMARY, Surface Water: please revise the fourth sentence of the second paragraph to read "Based on a ... it is ~~clear~~ *expected* that the ... these ~~streams~~ *drainages may* fit the characteristics of ephemeral waters."**

    Response: Comment noted and change will be made.

11. **EXECUTIVE SUMMARY, Surface Water: please revise the technology list of bullets to indicate NO ACTION as one alternative and *Monitoring* as the second alternative. Also, revise Table 6-1. Table still needs revision.**

    Response: Comment noted and change will be made.

12. **Section 1.1, page 1-1: please revise the second sentence of the first paragraph to read "The IA includes ... operations at ~~Chino's copper~~ mining and processing facilities."**

    Response: Comment noted and change will be made.

13. **Section 1.1, page 1-1: please revise the next to the last sentence of the third paragraph to read "Final remediation goals will be determined ~~when the remedy is selected~~ *in the Record of Decision.***

    Response: Comment noted and change will be made.

14. **Section 1.3, page 1-7: top paragraph, please revise "avian RAC" in the last sentence to "avian pre-FS RAC".**

    Response: Comment noted and change will be made.

15. **Section 2.2: please revise the second sentence of the second paragraph to read "Relevant and appropriate ... of the proposed response action *(relevant)* and are well suited to the conditions *(appropriate)* of the site."**

    Response: Comment noted and change will be made.

16. **Section 2.2, page 2-6: please revise the third sentence of the paragraph beginning "To constitute an ARAR" to read "Permits are considered to be procedural or administrative requirements, though may contain substantive requirements that are ARARs which must be attained and/or qualify as "to be considered" (TBC) materials that may be used in determining the necessary level of cleanup for protection of human health or the environment."**

    Response: Text will be revised to include: "Permits are considered to be procedural or administrative requirements, though may contain substantive requirements that are ARARs which must be attained and/or qualify as "to be considered" (TBC) materials that may be used in determining the necessary level of cleanup for protection of human health or the environment."

17. **Section 2.2, page 2-6: please add these paragraphs before the last paragraph "In addition to ARARs, non-promulgated advisories, proposed standards, criteria, guidance or policy documents developed by the federal or state government, or other information referred to as To Be Considered (TBC) materials may also be used in conjunction with ARARs to achieve an acceptable level of risk at a site. Although not legally binding, TBCs may be used when determining protective cleanup levels or response actions where no ARARs exist, or where ARARs alone would not be sufficiently protective of human health and the environment. Because TBCs are not ARARs their early identification is not mandatory."**

    "The state permit conditions for the Chino Mine shall be considered TBC materials and considered in the feasibility study for developing remedial alternatives."

    Response: Comment noted and change will be made.

18. **Section 2.4, Surface Soil, page 2-9: please revise the last sentence to read "Final remediation goals will be determined ~~when the remedy is selected~~ *in the Record of Decision*.**

    Response: Comment noted and change will be made.

19. **Section 2.4, Ground Water, page 2-9: the last sentence refers to the Sediment Leaching to Groundwater Report (ARCADIS 2011c); however, the Report is titled Groundwater Quality Pre-Feasibility Study Remedial Action Criteria for Drainage Sediments, April 2011. Please revise here and in the REFERENCES Section.**

    Response: Comment noted and change will be made.

20. **Section 2.5, page 2-10: please revise the last sentence to read "The current area ... and west of *the* ~~historical~~ *original* Smelter Investigation~~/Tailing soils~~ Unit ... ."**

    Response: Comment noted and change will be made.

21. **Section 3.1.1, Remedial Investigation: please revise the ERI reference to read "Phase II Remedial Investigation Report for the Ecological Investigation Unit".**

    Response: Comment noted and change will be made.

22. **Section 3.1.1, Human Health Risk Assessment: please revise the word "conservatively" to *conservative* in the second paragraph.**

    Response: Comment noted and change will be made.

23. **Section 3.1.1, Ecological Risk Assessment: the STSIU ERA was based on the results and conclusions of the sitewide BERA (NewFields 2006). The sitewide BERA was used as a tool to streamline the STSIU ERA and should be discussed after the Tech Memos.**

    Response: Comment noted, text will be added following the discussion of the Tech Memos – "The Site Wide BERA (Newfields, 2006) was completed and used as a tool for streamlining the STSIU ERA (Newfields, 2008).

24. **Section 3.1.1, Ecological Risk Assessment: please revise the last sentence before the bullets, it is inaccurate. The predicted levels of exposure have decreased, but the prediction of population-level risk has not changed.**

    Response Comment noted. The last sentence before the bullets will be revised to say "The updated exposure parameters have lead to a decrease in predicted exposure levels."

Additionally, to document Chino's position on what has and has not changed the following will also be added:

"The approved Site-Wide ERA (Newfields, 2006) documents a prediction of population level risk based on the earlier limited data. With the uncertainties in mind, Chino developed and NMED approved the Terrestrial Invertebrate Copper Bioaccumulation and Bioavailability Study for STSIU (ARCADIS, 2010) and subsequently field data were collected with NMED. The results of the data indicate that exposure levels have changed for the SGFB. If the Site-Wide ERA had been formally amended to include such data, the updated exposure parameters would result in lower LOAEL HQs and would update the conclusions of the Site-Wide ERA."

25. Section 3.1.1, Ecological Risk Assessment: please revise the last sentence of this Section. The risk conclusion has not changed, but the prediction of the rate of exposure has been lowered. However, exposure is still predicted to be above acceptable risk levels in many areas.

Response: The following sentence is now the last sentence in Section 3.1.1 – "When the above refinements are incorporated into the dose model for the SGFB, there is a decrease in the risk associated with the SGFB. The risk conclusion has not changed, but the prediction of the rate of exposure has been lowered. However, exposure is still predicted to be above acceptable risk levels in some areas."

26. Section 3.1.2: please revise number 3. 1) NMED does not consider the railroad track "a facility operations area". It is not covered by any Discharge Permit and the property owners have denied access to sample that property. This fact will be discussed in the Record of Decision. 2) Chino must provide written documentation that the NMDOT has agreed to accept all responsibilities relating to managing the copper contaminated soil in the Highway 180 ROW.

Response:

1) *Number 3 will be revised to read as "a supporting facility operations area".*

2) *Chino did not intend to suggest that NMDOT has agreed to accept all responsibilities relating to managing copper contaminated soil in the Highway 180 ROW. Rather, Chino's position is that human health risk is not at issue as part of a highway Right of Way (ROW), and, further, remediation is impractical and provides no value in these areas. For perspective, the Hurley "Golf Course" Interim Action Work Plan (IAWP) proposed applying the Hurley Soils IU remedial action criteria (RAC) of 5,000 mg/kg in those areas of the Smelter/Tailing Soils IU (STSIU) which may undergo residential development in the future. The highway ROW is NMDOT property and does not currently, and will not in the future, allow for a residential use. With respect to future construction in the ROW, Chino is currently awaiting documentation of the status of the projected GRIP highway construction plan, which should be adequate for establishing the highway ROW as a future construction site. Verbal communications with NMDOT has established that preliminary work for the four lane expansion plan has been completed, and at this time, the four lane expansion plan is awaiting funding. If NMED's question relates to future management of copper contaminated soils, Chino recognizes that if and when construction proceeds, impacted soils must be managed properly. Chino would expect to coordinate with DOT prior to construction and anticipates soils would be either capped in place or otherwise managed in compliance with existing regulatory requirements.*

27. Section 3.1.2: please revise number 4. This section should also address the pCu following remediation and compliance with the pCu pre-FS RAC.

Response: Item number 4 addresses interim remedial actions that occurred for the golf course areas. The remedial effort for the golf course removed the top 6 inches of soil, which is the maximum depth of *site-related impacts to soil in this area and the depth interval required for compliance with the March 3, 2011 RAC letter. Copper confirmation samples were taken and as stated in Section 3.1.2 the resulting copper concentrations meet the RAC requirement. The remediated area was reseeded and re-vegetated. Revegetation has met all success criteria stipulated by NMED. The following description has been added into the text.*

"The acres were deemed future residential as extensions of the town of Hurley and fall within the current city limits (based on the 2010 US Census boundary). At the time, however, within the areas exceeding 5,000 mg/kg, the excavation was completed vertically until the soils did not exceed 2,700 mg/kg. Chino calculated a spatially weighted 95 UCL for the areas included in the interim action of 1,314 mg/kg, which is in compliance of the SGFB pre-FS RAC of 1,600 mg/kg. The pre-FS RAC for pCu is based upon the 6 inch depth interval because the Ecological IU RI Report and subsequent risk reports document the fact that the acid and copper did not leach deeper than this depth interval and this is the depth most appropriate for ecological receptors. The remediation addressed the top 6 inches of soil, and copper concentrations were reduced. Since copper concentrations were demonstrated to be coincident with depressed pH along a gradient in the predominant wind direction (Schaffer, 1999; ARCADIS, 2001, Newfields, 2006), the remediation also addressed pH and, consequently, the pre-FS RAC for pCu."

28. **Section 3.1.2: please revise the last sentence in the short paragraph following bullet number 6 to read "Copper and iron ... and pCu ~~are the~~ exceed their respective ecological criteria."**

    Response: Comment noted and change will be made.

29. **Section 3.1.2, Copper: please discuss the statistical basis between the 0 - 1" and 0 - 6" soil results to support the approach.**

    Response: Comment noted and is addressed in the response to Comment No. 84. Text will be updated in Section 3.1.2 to refer the reader to Appendix A.

30. **Section 3.1.2, pCu: As discussed in the copper section, the soil samples from 0 - 1" appear to have a relationship with those at the 0 - 6" interval. The same relationship along with pH could also be used to calculate pCu and be shown on this Figure.**

    Response: Comment noted and addressed in the response to Comment No. 84.

31. **Section 4.1: please revise the second sentence of the first paragraph to read "These drainages are ~~generally~~ *commonly* considered ... water flow *generally* occurring ~~only~~ during and ... ."**

    Response: Comment noted and change will be made.

32. **Section 4.1: There are pools of persistent water in some of these drainages that should be mentioned in the first paragraph. The water in these persistent pools shall be investigated.**

    Response: Text will be revised to following "Other than these drainages, the remaining surface water bodies present in the STSIU are stock watering tanks and a small number of persistent pools in some of the STSIU drainages. Chino submitted a work plan to conduct a Hydrology Protocol completed in June 2011and the results will be incorporated into the FS." See response to Comment No. 122

33. **Section 4.1, page 4-2: the top paragraph has the wrong title referenced. Please revise.**

    Response: Comment noted and change will be made.

34. **Section 4.1, page 4-4, first bullet: Root uptake is not relevant for aquatic receptors. The ERA and CSM (Figure 3-1) indicate that direct contact and ingestion are complete and significant exposure pathways for aquatic life. Please revise.**

Response: Comment noted. Root uptake will be removed from the surface water CSM section (4.1).

35. **Section 4.1, page 4-4, second bullet: "Contaminated biota" are not listed as a complete and significant exposure pathway in the CSM (Figure 3-1). Direct contact and ingestion by terrestrial species are the exposure routes identified in the CSM. Please revise.**

    Response: Comment noted. Figure 3-1 will be updated to be consistent with text in Section 4.1.

36. **Section 4.1.1, Remedial Investigation: please add discussion about acute criteria which will connect to Section 4.1.2.**

    Response: Comment noted, text will be updated to include "The STSIU RI was completed by SRK in 2004, and then revised with the inclusion of new data and resubmitted in 2008 (SRK, 2004 and SRK, 2008b). Twenty four surface water samples were collected at 16 locations in the STSIU and were used to evaluate surface water quality. These results were presented in the Surface Water Addendum to the RI (SRK, 2008b).

    During the RI sampling, aluminium, barium, beryllium, boron, cadmium, calcium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, vanadium, and zinc were detected in STSIU surface water. Of these detected constituents, only cadmium, copper, and lead were detected at concentrations that exceeded the chronic aquatic life criteria (SRK, 2008a,b). Lead concentrations were not detected above acute aquatic life criteria. Cadmium concentrations exceeded acute criteria in three drainage locations and two stock tanks. Copper concentrations were consistently above acute criteria in drainage and stock pond locations."

37. **Section 4.1.2: please review and revise the first paragraph regarding acute criteria.**

    Response: Please see response to Comment No. 36. The following text will be added to Section 4.1.2 – "Cadmium, copper, and lead all had exceedances of their respective chronic aquatic life NMWQC, while only cadmium and copper had exceedances of their respective acute aquatic life NMWQC."

38. **Section 4.1.2, Copper: please revise this section. The criteria exceedences were not low (i.e., STS-WS-2010-A3 with copper @ 40.8 and a criteria of 10.63). Do not compare criteria exceedences to HQs.**

    Response: Text will be revised to remove any discussion of HQs and the text in Section 4.1.2 will be updated to read "generally low".

39. **Section 4.2: regarding paragraph 3. Does this imply that the BLM is not appropriate for use in this process? If so, additional information on why it is not appropriate should be provided.**

    Response: The first sentence of the 3rd paragraph has been updated – "Based on the current criteria in §20.6.4.10 NMAC and a preliminary review of Chino's surface water chemistry, WER and/or BLM procedures are appropriate for deriving site-specific metal criteria for surface waters at Chino."

40. **Section 4.2: please include cadmium in the last sentence of the third paragraph.**

    Response: Chino has submitted a Development of Criteria Adjustment Work Plan to the NMED Surface Water Quality Bureau. This work plan and subsequent studies will provide additional information regarding the spatial and temporal extent of metal concentrations in STSIU surface waters to further identify locations and/or metals that might require site-specific criteria. As indicated in Tables 4-1 – 4-3 of the STSIU FS Proposal, copper is the primary metal driver in surface waters, although cadmium concentrations exceed surface water criteria in a few locations (e.g., CDW-1-2004, ERA38 , and BD4W-1-2004) as described in Section 4.1.2. These slightly elevated cadmium concentrations appear to be isolated to the C-drainage area near the confluence of Bolton Draw. The available data indicate that metal concentrations (including cadmium) are potentially attenuating over time. For example, in 2004 cadmium *and copper concentrations at CDW-4 were 1.5 and 327 ppb, respectively. Sampling in 2007 at this location indicated respective concentrations of cadmium and copper of 1.3 and 221 ppb. Further, at sample location BD4W1, cadmium and copper were measured at 1.2 and 207 ppb in 2004 but decreased to 0.6 and 80 ppb, respectively, by 2007. This sample is the same location as STS-WS-2010-C-1, which showed a further decrease in each metal concentration by 2010 (Cd = 0.2 ppb, Cu = 34.8 ppb).*

Chino recognizes that available data may not be definitive regarding temporal reductions in metal concentrations, but a decreasing trend in metal concentrations in STSIU surface waters is apparent (Tables 4-1, 4-2 and 4-3). Potential metal attenuation in surface waters is particularly relevant when evaluating the nature and extent of cadmium concentrations because aquatic life criteria for cadmium were only slightly exceeded in a few sample locations. Thus, if metal concentrations in STSIU surface waters are attenuating, current conditions may preclude the need for development of site-specific criteria for cadmium. Because the complexity of WER studies increases substantially for scenarios dealing with multiple metals in a single waterbody, the proposed studies are intended to focus primarily on copper since this metal is the primary driver in STSIU surface waters. These studies will provide additional spatial and temporal data to facilitate a better understanding of the nature and extent of all metals in STSIU surface waters. If results from these studies indicate the need for development of site-specific cadmium criteria, based on current conditions, such criteria will be developed in conjunction with site-specific copper criteria using the aforementioned methods.

41. **Section 5.0, page 5-2: as mentioned earlier, please limit the first bullet to "No Action" and add a bullet for "Monitoring". Also revise Table 5-1. Table still needs revision.**

    Response: Comment noted and change will be made.

42. **Section 5.1: please revise heading to read "No Action" and revise this Section as needed.**

    Response: Section 5.1 will be revised to only discuss the "No Action" alternative.

43. **Section 5.1: please revise the third sentence to read "Monitoring would include ... and/or vegetation *and other biotic media*." When used in the "Monitoring" Section.**

    Response: Comment noted and change will be made.

44. **Section 5.1, Effectiveness: The reduction is short- and mid-term reduction in predicted exposure. Unacceptable levels of risk are still predicted in large areas of the STSIU.**

    Response: The word "risk" was replaced with "exposure" in Section 5.1, Effectiveness. As discussed in response to Comment No. 24:

    "The approved Site-Wide ERA (Newfields, 2006) documents a prediction of population level risk based on the earlier limited data. With the uncertainties in mind, Chino developed and NMED approved the Terrestrial Invertebrate Copper Bioaccumulation and Bioavailability Study for STSIU (ARCADIS, 2010) and subsequently field data were collected with NMED. The results of the data indicate that exposure levels have changed for the SGFB. If the Site-Wide ERA had been formally amended to include such data, the updated exposure parameters would result in lower LOAEL HQs and would update the conclusions of the Site-Wide ERA."

    Chino finds the NMED descriptive "unacceptable" premature in defining risk at this stage in the RI and FS process.

45. **Section 5.2: the wording of this heading does not correspond to the bullet list above. Please revise.**

    Response: Comment noted and change will be made.

46. **Section 5.3, Screening Result: please retain this technology and revise Table 5-1.**

Response: Text will be revised so that excavation and disposal will be retained and evaluated in the FS.

47. **Section 5.4: the wording of this heading does not correspond to the bullet list above. Please revise.**

Response: Comment noted and change will be made.

48. **Section 5.4: metals concentrations may not be reduced greatly by most amendments. Please indicate that bioavailability, toxicity, and mobility could be reduced.**

Response: The first sentence in section 5.4 has been updated to the following: "Many soil amendment technologies exist for reducing metals bioavailability, toxicity, and mobility in soils."

49. **Section 5.4, page 5-7: note, the power of these studies to identify effectiveness may be limited based on current design.**

Response: Chino is aware that the potential power of the current study is limited based on the small sample size. The power could be increased by increasing the sample size, but at this point Chino is addressing this through the NMED approved Amendment Study which should provide adequate data to select a remedial technology.

50. **Section 5.5: the end of the second paragraph refers to lowering pH, it should read "raise pH".**

Response: Comment noted and change will be made.

51. **Section 5.5, Effectiveness: tilling could also reduce COC concentrations due to mixing of surface materials with deeper soils that have lower concentrations.**

Response: Text will be revised to include this statement.

52. **Section 5.7: please revise subheading numbers.**

Response: Comment noted and change will be made.

53. **Section 5.7.1, Screening Result: please revise the second sentence to read "Soil washing is not ~~recommended to~~ be*ing* retained as a ... ."**

Response: Comment noted and change will be made.

54. **Section 5.7.2, Screening Result: please revise the last sentence to read "Therefore ... washing is not ~~recommended to~~ be*ing* retained as a ... ."**

Response: Comment noted and change will be made.

55. **Section 5.7.3, Screening Result: please revise the last sentence to read "Phytoextraction is not ~~recommended to~~ be*ing* retained as a ... ."**

Response: Comment noted and change will be made.

56. **Section 5.8: Implementability & Cost: will availability of adequate cover borrow sources and reclamation of borrow sources be considered in this analysis?**

Response: For Section 5.8 Costs will be updated with the following text: "Soil cover cost would include an analysis of cover borrow sources and reclamation of borrow sources, followed by installation of BMPs, and long term OMM costs."

57. **Section 5.11: Transpiration of gases does not seem applicable to copper or other metals for this site.**

Response: The sentence in the first paragraph of Section 5.11 has been updated to read as the following: "Metals are stored in the roots, stems, or leaves of the vegetation, effectively removing them from the soil." ~~or are changed into gases that are released to the atmosphere when the plant transpires.~~

58. **Section 5.13: please revise the first bullet to read "No Action" only. Add a second bullet for "Monitoring".**

    Response: Comment noted and change will be made.

59. **Section 5.13: please add "electrokinetic remediation" to the list of exceptions.**

    Response: Comment noted and change will be made.

60. **Section 6.0: please revise the first bullet to read "No Action" only. Add a second bullet for "Monitoring". Revise Table 6-1. Table still needs revision.**

    Response: Comment noted and change will be made.

61. **Section 6.0: Should ex-situ or in-situ treatment technologies be included in the preliminary screen, as well as technologies to address the re-emergence of subsurface alluvial water?**

    Response: Comment noted. Ex-situ technologies are included in the technologies, specifically in technology number 4. The text and corresponding table has been revised to clarify which of the technologies are specifically ex-situ. An in-situ technology will be included in the surface water technology screening and the text and Table 6-1 will be updated accordingly.

62. **Section 6.1: please revise heading to read "No Action".**

    Response: Comment noted and change will be made.

63. **Section 6.1: please revise the first sentence to read "This remedial ... surface water ~~on an ephemeral basis~~ with levels of ... ." Also revise Section as necessary for No Action alternative.**

    Response: Comment noted and change will be made.

64. **Section 6.3: note, this technology may not be a stand-alone alternative, but one that is used after excavation of contaminated sediments to contain residual metals.**

    Response: The technology described in Section 6.3 consists of construction of settling basins to remove suspended sediment loading to stream drainages. Metals entrained in the suspended sediments are thought to be the primary source for the metals transport pathway from sediment to surface water. Settling basins are one of the strategies that could be used to reduce risk by addressing transportation pathways rather than, or in addition to, source removal. The storm water study (Appendix B) was designed to confirm whether reducing suspended sediment loading rates will reduce or eliminate the transportation pathway of metal constituents to surface water. This information is one of several studies that will be evaluated comprehensively to determine the most appropriate remedial technology for surface water in the STSIU.

65. **Section 6.3, Effectiveness: please revise the second sentence to read "There are settling basins ... create ~~the ephemeral~~ surface water conditions."**

    Response: Comment noted and change will be made.

66. **Section 6.3, Effectiveness: the last sentence is unclear. Why will a limited number of basins cause a small quantity of sediments to NOT be removed? Please clarify.**

Response: The text will be revised to clarity the following: "However, because there would be a limited number of settling basins present, there is a potential for a small quantity of contaminated sediments to remain in the drainage downstream of the settling basins during high flow. During these high flow events, the limited number of settling basins may not slow the velocity of the runoff enough for the sediment to be removed from the water column."

67. **Section 6.6: please revise the first bullet to read "No Action" only. Add a second bullet for "Monitoring".**

    Response: Comment noted and change will be made.

68. **Section 8.0: the first reference to the ERI title should read "Phase II RI Report for the Ecological IU".**

    Response: Comment noted and change will be made.

69. **Section 8.0: the ARCADIS US, Inc. 2011c reference includes the wrong title. The submitted document was titled "Groundwater Quality Pre-Feasibility Study Remedial Action Criteria for Drainage Sediments". Please revise reference or submit revised title pages for hard copies and CDs.**

    Response: Comment noted and change will be made.

70. **TABLE 4-1, page 2: please shade HQ of 1.01 for location BD4W-1-2004.**

    Response: Comment noted and change will be made.

71. **TABLE 5-1, page 1: 1) please revise Item No. 1, REMEDIAL TECHNOLOGY to read "No Action" only; 2) add "Monitoring" as Item No. 2; 3) revise the new Item No. 3 as "Excavation and Reuse"; 4) revise old Item No. 4a to read "Limestone and Organic Matter"; and 5) revise old Item 3 (Excavation and Disposal) Conclusion to "Being retained ... ."**

    Response: Comment noted and change will be made.

72. **TABLE 6-1: 1) please revise Item No. 1, REMEDIAL TECHNOLOGY to read "No Action" only; 2) add "Monitoring" as Item No. 2; and 3) revise Item No. 4, REMEDIAL TECHNOLOGY to read "Limestone Treatment" as stated in Section 6.0.**

    Response: Comment noted and change will be made.

73. **FIGURE 1-1: note, the town of Hurley footprint is oversized. Please revise.**

    Response: Comment noted and all figures showing the town of Hurley footprint have been revised in terms of city limits and structures.

74. **FIGURE 4-1: please correct the spelling for Embankment.**

    Response: Figure 4-1 will be updated.

75. **FIGURE 7-1: items 10 and 12 should indicate 60 days for document review and/or approval.**

    Response: Figure 7-1 will be revised to allow for 60 day review/approval periods for items 10 and 12.

76. **Appendix A: the Field Sampling Plan should be adjusted to allow for collection of soil samples (3-4) from the 0-1" and 0-6" intervals from the Chino property west of Diaz Avenue and east of the railroad right-of-way. This area was not sampled during the Hurley Interim Remedial Action or during the STSIU "golf course" Interim Removal Action.**

    Response: Chino collected samples for this area south of Carrasco Street and west of Diaz Street while performing the Hurley Golf Course IRA to take advantage of the on -going IRA sampling program that *was currently in place. Based on the gradient for copper concentrations defined during the Hurley IU IRA, this area was expected to fall well below the 5000 ppm copper RAC for human health and the sample results support this. These data will be incorporated into the Appendix A sampling results report. Chino now has a legal survey to define the Southwest Railroad property and railroad Right of Way for the northern portion of the area in question. Chino proposes to perform a supplemental action to the STS IU Hurley Golf Course IRA and address non-railroad property and Chino non-operational property to address this area in the town of Hurley.*

77. **Appendix A, Section A.2: this section should include a discussion of the requirements for monitoring if copper concentrations are between 1,100 and 1,600 mg/kg per the dispute resolution letter dated 3/3/11.**

Response: The bulleted list in Section A.2 has been revised to state that monitoring plans will be developed in the event that copper concentrations are between 1,100 and 1,600 mg/kg. However, the requirements for monitoring should be developed upon determination of the extent and distribution of soil copper within this range, and the specific remedies selected and residual risks that may remain. Specific monitoring requirements will therefore be developed in the FS upon analysis of the new data and selection of remedies.

78. **Appendix A, Section A.2: The OAT score and how it relates to rangeland condition shown on Figures 1 and 3 needs to be defined in the text. In addition, the limitations of the mapping including a discussion of the time frame in which the mapping was completed and the methods used to complete the mapping also need to be presented.**

Response: Comment noted. The Observed Apparent Trend (OAT) score and how it relates to rangeland condition will be defined in greater detail in Section A4.1 and additional text will be added to Section A4.1 summarizing the following:

The Observed Apparent Trend (OAT) Score is one measure of rangeland condition and will be used to assess rangeland condition in areas with pCu < 5. This method was used in 1997 when upland associated with STSIU was investigated by Woodward Clyde (1997). The method was used to estimate "apparent" trend in rangeland condition without sampling more than one time period. Woodward Clyde (1997) prepared a sampling plan but not a report summarizing their results. However, the datasheets with their results are available. OAT scores were measured in rangeland polygons shown in Figure 1 and 3 in 1997 using criteria in Table 1. The score is a sum of points for plant vigor, reproduction, surface litter, and pedestals. Pedestals and low surface litter indicate erosion of the soil and poor productivity. A high score is an area with low soil erosion and healthy, vigorous, desirable reproducing vegetation for grazing animals. A list of desirable New Mexico range plants is available in a New Mexico State University agricultural extension circular 374. A high score represents good rangeland condition. The cutoff for fair to good rangeland (referred to as static to upward in observed trend scores) varies depending on the area. For example, BLM EIS, Drewsey Resource Area in Oregon used 17 as the cutoff, which was also used by NRCS in Wyoming. We determined the cutoff for Chino by evaluating other rangeland condition sampling results on soil stability and plant distribution in 1997 in these same areas (see worksheet in Appendix B of Woodward Clyde 1997) which produced preliminary rangeland classifications ranging from Excellent, Good, Fair, to Poor. Comparing the OAT score to these classifications in Table 2 suggested ≥22 is mostly fair to good rangeland (note on p. A-7, we reference Table 1 for our justification for selection 22 as the cutoff but we should have referenced Table 2).

This OAT method is a rapid assessment technique promoted by the BLM and NRCS whereby the investigator walks through a defined area and visually estimates the scores. The survey write-up areas (SWA) assessed for OAT scores were soil-vegetation polygons that were created by intersecting the soil and vegetation polygons in the Site-Wide ERA. We refer to these polygons as rangeland polygons. These rangeland polygons are proposed as exposure units for pCu. Figures 1 and 3 show the rangeland *polygons and the OAT score estimated for each of these polygons in 1997. Because the data were collected in 1997, it is uncertain if they apply to today's conditions. Thus, 15 of the polygons (each is numbered HExx on Figure 1 and 3) will be evaluated for the OAT score again in 2011 to compare to the 1997 score to see if they are still valid and to develop a relationship between OAT scores and spectral signatures using remote sensing. Remote sensing techniques will allow Chino to predict OAT scores in unsampled areas in 2011 and in future years.*

79. Appendix A, Section A4.1, pCu: see previous comments. The figures are referenced prior to an introduction of the data presented in them.

Response: The text in Appendix A will be revised to introduce the approach and provide more substantial background before interpretive figures are shown.

80. Appendix A, Section A4.1, pCu: This document fails to note previous comments from NMED on the rangeland sampling and analysis. The density of the sampling conducted for the referenced analysis was too low to assess the effect within the potentially affected area. Some sampling units just east of the smelter/Lake One area were a mile wide. The copper concentration and pH within this area changes substantially with distance from the smelter.

Response: Previous comments from NMED on the rangeland sampling and analysis were understood and, in fact, the sampling outlined by Chino in the STSIU FS Proposal is designed to be responsive by obtaining more data with respect to rangeland condition. Moreover, on page A-7, last paragraph, it is noted,

> *"While there are a number of 1997 rangeland condition polygons that cover the pCu<5 area, little is known of the wildlife habitat quality in this area based upon the indicators relied upon in the ERA (Newfields, 2006)."*

It is clear that the density of sampling in the 1997 study was too low to assess effects to rangeland condition within the pCu<5 contour. The sampling for the OAT score was ocular estimation of plant and soil characteristics by individuals spending on average 40% of the day in the field walking through the polygon to estimate representative conditions. The methods provided in Appendix A are intended to augment and update the 1997 rangeland condition data.

81. Appendix A, Section A4.1, pCu: relating to page A-7 third paragraph. Please explain how the OAT score map will be updated and how the rangeland evaluation will be conducted?

Response: Section A6.4, Vegetation SOPs, document the field rangeland evaluation and the paragraphs below provide more detail that will be incorporated into Section A6.4. A sentence will be inserted into Section A4.1 that refers the reader to Section A6.4 for this information. Likewise, Section A8.3 explains how the OAT score map will be updated and more detail is provided below that will be incorporated into Section A8.3. A sentence will be inserted into Section A4.1 that refers the reader to Section A8.3 for this information.

The following text will be added to Section A6.4 – "At 15 sampling points shown on Figure 3, each within one of 15 rangeland polygons and within the approximate pCu <5 contour, a 200-m transect will be walked and an OAT score recorded using the worksheet in Table 1. Before sampling the transect, the polygon will be walked as they did in 1997 to evaluate the criteria used in developing the OAT score for the entire polygon. The score on the 200-m transect will only be used to correlate to the corresponding pixel on the remote sensing map. The field investigators from NMED and Chino will jointly decide on the scores and will not be able to refer to the 1997 results to avoid biasing their results."

The below text provides additional explanation of how the OAT scores will be mapped and updated:

An attempt will be made to determine if 15 of the 1997 OAT scores of each polygon can be correlated to the new OAT scores. If the new OAT scores can be correlated to the 1997 OAT scores, then a regression equation will be used to update OAT scores of polygons not sampled. The new scores may not be directly relatable to the 1997 scores due to potential differences in sampling methods and change in observers. If the 1997 OAT scores cannot be correlated directly to the new OAT scores (correlation <0.8), the 1997 OAT score data will be updated using remote sensing, and evaluated along with the data from new locations. However, if the correlation is good, remote sensing will not be needed to update the OAT map.

If remote sensing is required, the relationship between spectral image data (from a remotely sensed image) and the OAT score will be calibrated using the 15 sampling points discussed above. To update the map, the field transects will be located on a satellite image taken over the site in August or September 2011 (same process used when Chino tasked a satellite imagery collection over the site in August 2010 to support informal dispute resolution). The image will be a Quickbird Satellite Image of 4 bands (red, blue, green, and infrared) sharpened using a panchromatic band to a spatial resolution of approximately 0.5 m. A 4-band spectral signature on each 200 x 200 m section centered on each 200-m field transect for all 15 OAT locations will be plotted in multi-dimensional space and calibrated to their OAT scores. A model based upon spectral distances among OAT score clusters will be developed to predict OAT scores for every 200x200 m section (unsampled and sampled) on the image, with pixels generalized from 0.5 m to a 200 m resolution. Variability of spectral signatures in the 0.5 m pixels within a 200-m pixel will also be measured if required to improve the ability of the model to separate OAT scores (e.g., a moderate OAT score may have more variability with a mix of bare and vegetated 0.5 m pixels than a poor OAT score with mostly bare ground).

Other prediction methods such as (1) a simple regression of OAT scores on a normalized difference vegetation index calculated from the four bands or (2) a multiple regression of OAT scores on the spectral values of the 4 bands may be used if they provide more predictive models than the spectral distance approach. Such methods require only 15 (multiple regression) or 8 (simple regression) samples to obtain a significant ($P< 0.05$) regression with an r^2 of 0.5 and a statistical power of 0.8. If such models have lower r^2, then higher samples must be obtained. Similarly, if root mean square error (error in OAT score units typically found on map, similar to standard error) is high enough to provide poor prediction of fair/good vs. poor rangeland condition, more samples will be taken to reduce the error. Covariates such as distance to water may be added to the spectral models to improve prediction and the final OAT map.

An effort will be made to ensure ends of the OAT spectrum (very poor and excellent) are captured. If a first sampling session produces high standard errors or root mean square errors that lead to poor predictions relative to observed data, or if the area with pCu < 5 and soil copper >327 mg/kg turns out to be larger or distributed differently than current data supports, then a second sampling event may be required to adequately capture the range of OAT scores on the site.

The map predicting OAT scores for every 200 m section in areas with pCu < 5 will be segmented into pixels with an OAT score < 22 and ≥ 22. These pixel values will be averaged within each rangeland polygon to obtain final OAT score estimates. If the image shows sharp boundaries that can be delinieated within rangeland polygons, then new rangeland polygon boundaries may be defined, splitting the polygons into smaller ones..

As stated in the work plan, the accuracy of the rangeland map will be assessed by first converting the OAT map into a binary map of two rangeland classes: good-fair vs. poor rangeland conditions with a cutpoint of 22. Similarly, field transect OAT scores will be converted into these two classes. The overall accuracy and percentage of poor field scores not rated as poor by the map (errors of commission), percentage of good-fair field scores not rated as good-fair (errors of omission) by the map, and overall *percent correct classification of all field scores will be recorded. If the spectral distance approach or other alternative satellite map calibration approach achieves 70% overall accuracy and < 15% errors of commission, then the remote sensing approach will be used to update the map. Because this accuracy assessment is based upon only two classes, error is likely to be low.*

82. **Appendix A, Section A4.1, pCu: relating to page A-7 fourth paragraph. Please provide a reference to the specific MMD guidance being cited.**

Response: Text has been updated to reference the DS&A 1999.

83. **Appendix A, Section A4.1, pCu: relating to page A-8 last paragraph. A definition of how average pCu will be calculated must be provided as well as an indication of why Chino believes that an average pCu measure is applicable versus a statistical estimate of the lower bound of the mean pCu.**

Response: Comment noted and the last sentence in Section A4.1 will be updated to – "These polygons will be evaluated for a remedial alternative to comply with pCu Pre-FS RAC."

Although the FS Work Plan previously mentioned the use of "average" or "spatially weighted average" this language was inexact and we are not proposing to calculate an "average" concentration per polygon. Our approach involves a statistically supported Kriging method which predicts pCu based upon observed data, as described in more detail below. This approach is supported based on previous consideration of pCu in the Site-Wide ERA (Newfields, 2006).

Based upon Figure 2.5-6 "Total Copper Concentration vs. Soil pH for given pCu2+" in the Site-Wide ERA (Newfields, 2006), total copper and pH covary and copper concentrations are shown to be on a gradient with decreasing concentration with distance from the smelter considering the predominant wind direction. While pH does not always follow the same pattern as copper, particularly due to the variable buffering capacity of site soil, pCu tends to follow the strong spatial gradient of total copper. The Site-Wide ERA says community parameters appear to be correlated with average pCu conditions (Newfields, 2006, page 2-22). The management endpoint documented in the Site-Wide ERA indicates that plants support habitat for wildlife and livestock, and the pre-FS RAC for birds is based upon a population endpoint. Based upon the conclusions of the Site-Wide ERA, the pCu threshold of 5 protects plants from being reduced in size (emergence is not affected until much lower pCu) or protects plant communities from shifts in species composition. Reduction in plant size or shifts in species composition are less of a threat to the wildlife populations because the prey base can still exist upon smaller plants and wildlife can continue to forage upon this prey base. Therefore an average pCu is protective of plants that support habitat for these populations.

A robust synoptic dataset for pCu, calculated from co-located copper and pH data, does not exist. The STSIU FS proposal includes additional samples to support a statistically sound and rigorous kriging model, as described more fully below. The overlap between contours estimated via Kriging and rangeland/wildlife condition will be used to prioritize areas for evaluation in the FS. This level of resolution is appropriate going into the FS and the FS Report will summarize specific remedial approaches as well as an approach for determining compliance to be documented in the Record of Decision (ROD).

After investigating the current dataset, Chino found that the data lend themselves to use of a statistically sound and rigorous Kriging model that minimizes estimation error. Such a model depends on the site having a strong spatial gradient in pCu (driven primarily by the total copper gradient) and high autocorrelation. The current pCu dataset creates a good semi-variogram (Fig. 1), showing high spatial autocorrelation up to 20 km. This means nearby points are more similar than points far apart as expected if pCu is decreasing with distance from the smelter and tailings ponds. Thus, Chino proposes this Kriging technique for interpolating pCu, which allows statistical evaluation of the error, and reduces sampling *effort because it should be able to predict areas unsampled with reasonable accuracy. We will modify Section A8.1 of the FS Proposal to show this analysis and choice of Kriging as the interpolation method for pCu. In addition, the sentence on page A-18 that says, "The spatially-weighted average..." will be modified to say that "the estimated pCu concentration represented by the area within the Kriged boundary of pCu<5 will be used to screen exposure unit polygons." In other words, rangeland polygons that intersect the pCu<5 contour line will be those evaluated for remedial alternatives. While it does not technically represent a lower confidence limit (LCL) on the mean because it does not take into consideration a standard deviation, the fact that estimation error is minimized by the underlying Kriging algorithm and a spatial gradient with high autocorrelation, the "average" concentration within the Kriged boundary is appropriate for this level of analysis to support an evaluation of FS technologies and remedial alternatives.*

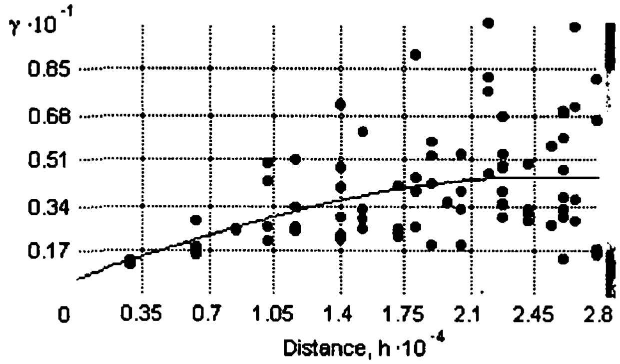

Figure 1. Semi-variogram plotting semi-variance against distance between points using the current pCu dataset shows strong autocorrelation among points until a distance of about 20 km. The line fit to the points on the plot shows the variance between points increases as the distance between the points increases until it reaches a maximum at a certain distance, causing a flat region to occur on the semi-variogram, which is called the "sill". Where the sill begins, spatial autocorrelation (values for points are more similar when they are near each other than far) does not occur. The semi-variogram is a good fit to the data because the scatter of the points around the fitted line is relatively low at small distances and, as expected if there is no autocorrelation beyond 20 km, is highest at the sill.

84. Appendix A, Section A4.2: relating to the first paragraph of Part 1. A statistical interpretation of the data must be provided to justify the use of the ratios in the assessment if the 0 - 1" data are to be used in the assessment. A simple statement of the median relationship is not adequate to support the decision.

Response: Please see attached excel file with a table showing the paired data for pH and Cu at 0-1 inch and 0-6 inch and figures plotting the pairs of data. This table will also be included in Appendix A as Table 3 and the following text will be included in Section A4.2:

"Not all samples were collected at 0-6 inch bgs. The concentrations of samples at 0-1 inch bgs were multiplied by 0.7 to represent the 0-6 inch bgs based upon the finding that the ratio of 0-6 inch to 0-1 inch depth strata for copper is 0.7 (median of 37 co-located samples, Table 3) in soils without deposits of windblown tailings. For soils in areas with windblown tailings, the multiplier was 1.5 (median of 7 co-located samples, Table 3). These median ratios were chosen after the average and median ratio, and slope of the regression of a plot of 0-1 inch data against 0-6 inch data (where the slope is essentially a ratio) were compared (Figure 4). The slope of the regression had the lowest value and the median and average ratios for copper were very similar. The median was selected as best because, unlike the regression slope, it was not strongly influenced by the two highest data values, was more conservative than the regression slope, and best represented central tendency because the ratio data were not normally distributed (Shapiro Wilk test, $P < 0.01$). For sites in windblown tailings, where the tailings have

low copper, the ratio flips so that the 0-1 inch stratum has lower copper than the 0-6 inch stratum on average. The median was the most conservative method for these data and was selected to be consistent with the method chosen for areas outside the tailings."

The following information is additional justification for using the median ratio for converting 0-1 inch to 0-6 inch copper:

The median ratio (0-6 inch/0-1 inch), average ratio, and slope of the regression of a plot of 0-1 inch data against 0-6 inch data were compared to determine which is the best ratio to use. The ratio for pH was near 1.0 for all methods and thus no adjustment was made for pH (also, all 0-1 inch pH data was collected pre-white rain). Data for areas with windblown tailings were too sparse and variable to be certain of a difference in pH with depth in those areas.

However, for Cu in sites outside the windblown tailings areas, the copper concentration averaged lower in 0-6 inch stratum than the 0-1 inch stratum. The slope of the regression had the lowest ratio (and thus is least conservative) and the median and average ratios for Cu were very similar (within 0.02, a difference that would not influence the spatial interpolation or 95UCL) with the average slightly higher. The median was selected as best since, unlike the regression slope, it was not strongly influenced by the two highest data values, was more conservative than the regression slope, and best represented central tendency because the ratio data were not normally distributed (Shapiro Wilk test, $P < 0.01$). For sites in windblown tailings, where the tailings have low Cu, the ratio flips so that the 0-1 inch has lower Cu than the 0-6 inch on average. The median was the most conservative method for these data and was selected to be consistent with the method chosen for areas outside the tailings.

85. **Appendix A, Section A4.2: relating to the second paragraph of Part 2. A description of this process must be provided or a reference to the appropriate section must be provided.**

    Response: The text will be revised to reference Section 2 from the DSB&A 1999 Report.

86. **Appendix A, Section A4.3: second paragraph. The dispute resolution letter indicates that actions must be taken if the 95UCL is greater than 1,100 mg/kg but less than the pre-FS RAC. As a result, 1,100 mg/kg should be the trigger used to calculate the 95UCL for the exposure unit.**

    Response: Comment noted. Section A4.3 will be revised to add that each polygon with a copper concentration greater than 1,100 mg/kg will trigger the calculation of 95UCL for the given polygon.

87. **Appendix A, Section A4.3, page A-10: see paragraph beginning "For total copper". This is the first place that borrow areas are discussed; more information is required. If an area is defined as a borrow area and contains more than 1,100 mg/kg, NMED needs to have some assurance that it will be used as a borrow area and not allowed to remain in its current state without consideration as described above to address elevated copper concentrations.**

    Response: A discussion of the borrow areas will be provided in the FS report to describe the areas designated as borrow (an engineering diagram will also be provided showing locations). All areas not used for borrow will be handled in the FS.

88. **Appendix A, Section A4.3, page A-10: see paragraph beginning "For pCu". The definition of "acceptable" must be provided for review.**

    Response: The appendix will be amended to define acceptable" and "unacceptable" wildlife habitat as the following:

Acceptable wildlife habitat for ungrazed areas will be defined as having cover ≥32% and plant species richness ≥8, in accordance with MMD guidance and revegetation success guidelines developed for Chino (DBS&A, 1999), assuming climatic conditions are relatively similar to conditions of the reference plots used to assign these criteria (DBS&A 1999). Grazed areas will be defined as having at least as much cover and as good or better species richness as the reference plot to be established in the Lampbright Draw area, in order to reference a grazed plot that was not impacted by mining operations. The relevance that the above benchmarks reflect habitat quality is that MMD guidance dictates a post-closure land use must be a self-sustaining ecosystem.

89. **Appendix A, Section A4.3, page A-10: see paragraph beginning "For pCu". The procedure for spatial weighting of data must also be provided.**

Response: Comment noted and is addressed under the response to Comment No. 116. Text will be updated to refer the reader to Section A8.3 for details on the evaluation of pCu.

90. **Appendix A, Section A4.3, page A-10: see paragraph beginning "For pCu". Areas with pCu < 5 and fair to good rangeland conditions and acceptable wildlife habitat are not addressed. Procedures for verifying rangeland conditions in these areas must be provided. Verification of rangeland conditions must be made before any area with pCu < 5 can be excluded from further consideration.**

Response: The areas with pCu <5 and fair to good rangeland condition or acceptable wildlife habitat will not be considered for remediation but will be addressed in the FS. See response to Comment No. 81, which addresses procedures for verifying/updating rangeland conditions in such areas. Chino is amenable to conducting some additional, validation rangeland sampling in areas with pCu < 5 that are classified as good to fair rangeland or acceptable wildlife habitat after the analysis is completed. Procedures for verifying rangeland conditions will be based upon those identified in Section A8.3 and in our response to Comment No. 81, but will be further developed and presented in the FS Report as an appendix after such area is identified through the sampling proposed in the work plan.

91. **Appendix A, Section A4.3, page A-10: last paragraph. How will these errors be calculated and verified?**

Response: Comment noted and text will be updated to – "Accuracy of the remote sensing maps delineating good and poor condition rangeland and acceptable and unacceptable wildlife habitat will be set to 70% correct classification using jackknife cross-validation (sample being predicted is removed from calibration dataset to develop the model."

Additional explanation is included in comment 81 and in the below text.

The field data used for the error classification will be a jackknifed cross-validated dataset. In other words, to ensure accuracy is assessed on an independent dataset, the data point being predicted will not be included in the model development. Models (relationships between spectral data and OAT scores for example) and their produced maps will be developed for each field datum without that datum and then the value of the datum predicted. The percent of data points correctly classified is then determined.

92. **Appendix A, Section A4.4, pCu Sampling Design: Please revise the first sentence to read "The ~~threshold of concern~~ *pre-FS RAC* for pCu is 5." Please provide a brief discussion of the conclusions on the sitewide BERA indicating the potential effects of pCu < 5.**

Response: The text will be revised to include the following: "The Sitewide BERA indicated that when pCu<5 there is a significant reduction in richness and canopy cover." Chino does not necessarily agree with this statement due to the three following issues:

- a. *The vegetation community analysis comparing Site data to the upland reference location contains substantial uncertainty due to the upland reference locations are located in relatively* *homogeneous soil type, elevation, and ecology: whereas, the vegetation in the STSIU represents a diverse and complex ecology that has been shaped by numerous forces.*

b. *The phytotoxicity studies used to correlate pCu effect levels are not relevant to STSIU vegetation as they were conducted using non-native test species, not all phytotoxicity endpoints have the same ecological relevance, and there are many factors that may confound the phytotoxicity results.*

c. *The use of the vegetation community analysis and phytotoxicity studies to determine the DEL and PEL for pCu needs additional justification given the above two concerns.*

93. Appendix A, Section A4.4, pCu Sampling Design: regarding the second sentence. None of the figures include a zone of uncertainty or a description of what this zone constitutes. Please add explanation.

Response: The red dotted lines on the maps in Figure 5 and 6 outline the zones of uncertainty. This omission in labeling will be corrected on the revised figures. The zone of uncertainty includes areas that were pCu < 5 pre-white rain but not post-white rain in addition to those areas currently identified as pCu < 5. This description will be added to the text.

94. Appendix A, Section A4.4, pCu Sampling Design: because the permanence of the effects of the white rain is currently unknown, pre-white rain data should also be mapped and considered in the sample location selection.

Response: Comment noted. The zone of uncertainty is described in Comment No. 93. Chino does not agree to consider pre-white rain data in the sample location selection because the pH monitoring work plan will be implemented over five years and the outcome of the extent of contamination will not be known until the end of the pH monitoring. The ROD will not be released until after the pH monitoring is completed as well as the amendment study. The proposed sampling in the FS Proposal will provide data to refine the spatial area that is the focus of technology evaluation and remedial alternatives in the FS. Changes to the spatial area will be documented by the annual pH monitoring report and can be incorporated into the overall remedy design after the ROD is finalized.

95. Appendix A, Section A4.4, pCu Sampling Design: regarding top of page A-12. Areas of high copper concentrations in the 0 - 1" interval were identified along the western side of the tailings ponds between the highway and the tailings ponds. The sampling area should be expanded to fill data gaps in this area.

Response: This area is a planned borrow source for reclamation and 12 soil samples have been collected during the STSIU RI on the western side of the tailing dams. Given the large number of samples in this small area, Chino will use existing data to complete an analysis of remedial technologies.

96. Also, additional samples should be located to the north and east of the proposed sampling location UN04-2513. There is a large area of unknown pCu that is not bounded by areas of pCu > 6.

Response: Eleven additional shallow soil (0-6 inch bgs) samples have been added to better characterize the area to the east and northeast of UN04-2513.

97. Appendix A, Section A4.4, pCu Sampling Design: regarding the last paragraph. Details on how these measurements will be collected needs to be provided.

Response: The paragraph referred to in the above comment describes an aspect of the sampling program to determine local scale variability in pCu. However, as noted in Comment No. 118, this measure is not of particular interest or importance to NMED. Therefore, this aspect of the sampling program has been removed from the appendix.

98. **Appendix A, Section A4.4, Vegetation Sampling Design: regarding the third paragraph. Please provide some rationale relating to how applicable data collected at 15 locations will be used to verifying (*verify*)habitat and range condition over the entire area of concern and multiple vegetation alliances.**

Response: Comment noted and partially addressed in Comment No. 81. In the response to Comment No. 81, we address how the 15 samples are used to calibrate a remote sensing model and map that will use spectral data for the entire site on every 0.5 m pixel on the site across all vegetation alliances, not just 15 sample locations. That is an extensive dataset. Without the massive and extensive spectral dataset provided by the remote sensing image, 15 samples certainly would be inadequate. If the remote sensing map has poor prediction accuracy, the ground sample size will be increased as discussed previously and estimates will be made using traditional field sampling procedures. The approach outlined using remote sensing for developing the rangeland map will be the same approach used for developing the wildlife habitat map except richness and cover will replace the OAT score as the variables being measured in the field and predicted on the map.

99. **Appendix A, Section A4.4, Vegetation Sampling Design: regarding the third paragraph. What is the source of remotely sensed data, how current is it, are new images going to be acquired and what is the resolution of the images to be used?**

Response: Please refer to the response under Comment No. 81.

100. **Appendix A, Section A4.4, Vegetation Sampling Design: regarding the fourth paragraph. More detail is needed to define what will be considered efficient (*sufficient*) and what will be considered insufficient.**

Response: Remote sensing images can provide information on every 0.5 m of the site and be processed quickly in computer software (ERDAS Imagine and then ARCGIS), which is highly efficient. Field work can only sample a small portion of the site and can easily miss irregularities or spatial changes in vegetation conditions due to the large spatial extent of the site. As long as the relationship between vegetation indices (OAT scores, richness, cover) and spectral data and its covariates can be modeled with reasonable accuracy, remote sensing maps will be both efficient and more than sufficient and even useful for future monitoring if future images are obtained. The maps will be considered insufficient if they do not meet the accuracy benchmarks outlined previously under the response to Comment No. 81. If the maps are insufficient, the less efficient, more costly field sampling approach will be used, with a sampling design developed at that time.

101. **Appendix A, Section A4.4, Vegetation Sampling Design: regarding the end of the fourth paragraph. More detail is needed to define what a sample of boundaries indicates. In addition, it is not clear how the same type of information will be assessed within the large polygons.**

Response: The original soil and vegetation boundaries used to create the rangeland polygons were developed using extensive field sampling by the NRCS and DBS&A and it is assumed they represent relatively homogeneous vegetation/soil conditions. When the sampling results are interpreted and image segmentation is applied, however, the boundaries of the final ecological exposure units may be modified if they do not capture obvious changes in rangeland condition. Additionally, once the boundaries between fair-good and poor are delineated, three or four of these boundaries will be driven or walked to verify that the rangeland difference is visible between the units.

102. **Appendix A, Section A4.4, Vegetation Sampling Design: regarding the fifth paragraph. The definitions of acceptable and unacceptable have not been provided and the relevance of the benchmarks indicating wildlife habitat quality is not clear.**

Response: Comment noted. Please see response to Comment No. 88 regarding the definition of acceptable and unacceptable wildlife habitat.

103. Appendix A, Section A4.4, Vegetation Sampling Design: regarding the last sentence of the fifth paragraph. Does this include field verification as discussed above or is this an additional measure?

Response: This is an additional computational measure to evaluate if cover or richness changes sharply within a rangeland polygon (an obvious visual change on an aerial photo), great enough to change the boundary. Also see response to Comment No. 102.

104. Appendix A, Section A4.4, Upland Copper Sampling Design: first paragraph. How was 300 mg/kg selected as the minimum delta? Please also define how these statistics are applicable in a situation where copper concentrations are based on a gradient.

Response: A delta of 300 mg/kg for copper was chosen as a "minimal detectable change of interest" because it represents about 300-m band width on average for concentric zones contoured around the smelter and narrower bands are harder to distinguish and require much greater sample sizes.

The proposed statistics are applicable in this situation where copper concentrations are based on a gradient because even though the standard deviation is tighter across segments within the gradient, there are clear data gaps across the whole gradient. Since there are three pre-FS RAC for total copper ranging from 1,100 to 5,000 mg/kg, our zone of interest is greater than a specific band width in the gradient. Instead, the site was stratified into a zone of uncertainty near and surrounding the smelter and a zone beyond that. While Chino could have split the zone of uncertainty into smaller distance bands around the smelter and estimated sample size for each of these strata, such an approach is less conservative, producing small sample size requirements and assumes the gradient model is robust. It may be robust but Chino decided to err on the conservative side. Thus, a standard deviation was estimated for the whole dataset, and a sample size equation was run to determine sample size. The gradient nature of the site was accounted for by the pattern of the samples placed along transects perpendicular to the gradient that will best capture the changes in Cu and the threshold boundary of concern.

105. Appendix A, Section A4.4, Upland Copper Sampling Design: last paragraph. How will the data be used if there is no significant correlation between the XRF and laboratory samples? What constitutes and acceptable level of correlation between the datasets. How was n= 9 determined to be an acceptable number of samples to provide confidence that the correlation between the two data sets is adequate for use in decision making? How will these samples that will be collected using completely different sampling protocols be related to existing samples?

Response: Chino has historically found significant correlations (r^2>0.8) between XRF and site copper samples when XRF was used during the Hurley Soils Removal Action and the STSIU Interim Removal Action for the Golf Course Soils. Consistent with two previous studies, Chino will use USEPA Method 6200 to determine the relationship between site and XRF samples. Using an r^2=0.8, Chino derived the sample size required to determine a significant regression. Chino determined that a minimum of five samples is needed to determine a significant r^2. Chino is currently proposing the collection of nine samples, which satisfies this verification need. The correlation between the laboratory samples and XRF samples will be used to relate the remaining XRF samples to the site samples.

106. Appendix A, Section A4.4, Drainage Copper Sampling Design: first paragraph. Please define the acronym NDVI.

Response: Text has been updated to define NDVI (Normalized Difference Vegetation Index).

107. Appendix A, Section A4.4, Drainage Copper Sampling Design: first paragraph. Please discuss how remotely sensed data will be compared to field verification data and indicate the source and date of remote data is provided. It's not clear how NDVI and near spectrum data will be compared and no discussion of the difference between the two is provided.

Response: Field verification data will consist of estimates of percent woody cover taken along 1 100-m transect (divided into smaller homogeneous transects if heterogenous) along the bank parallel to the drainage and 1 100-m transect in the nearby upland (at least 500 m away) at each sampling point in Figure 4. The line intercept method will be used, measuring the percent of the transect intersecting woody vegetation canopy. The upland transect will be parallel to the bank transect. These data will be used both to calibrate satellite imagery models and to assess accuracy of the models. Satellite imagery will be a Quickbird satellite image collected in August or September 2011. The Quickbird sensor collects an Image in 4 bands (red, blue, green, and near-infrared) which will be sharpened using a panchromatic band to a spatial resolution of approximately 0.5 m.

The difference between NDVI and near spectrum data (more precisely the near-infrared portion of the electromagnetic spectrum) is that near-infrared data are used to calculate NDVI but near near-infrared also can be used alone as a vegetation index. There are many vegetative indices that rely on comparison of the near-infrared portion of the spectrum (wavelengths of 0.7-1.3 micrometers) to other spectral bands, because of the high reflectance in near-infrared of vegetation undergoing photosynthesis. The Normalized Difference Vegetative Index (NDVI), is a commonly used index, which is calculated as: (NIR – red)/(NIR + red), where "NIR" is spectral response in the near-infrared wavelength and "red" is the spectral response in the red wavelength. This index emphasizes the contrast between NIR response and general brightness, and tends to return values near -1 for water, near 0 for bare ground, and positive values for vegetation, with values closer to 1 indicating more vigorous vegetation.

Vegetative index values can be calibrated with field measurements of vegetative cover (in particular to find index values below which there is no cover and above which there is full cover) to establish a relationship between an index value and percent cover. The model will provide a percent cover estimate, which can be compared to field measurements not used for calibration for accuracy assessment (using cross-validation—see comment 91). Because field cover can generally only be estimated to with approximately ±10% cover (absolute percent) with consistency, this will be the standard used to measure the accuracy of satellite measurements. That is, cover modeled to within 10 percentage points of ground reference will be considered "correct" in the accuracy assessment. The accuracy requirement must be at least 70% to use the remotely sensed results to compare upland and drainage vegetation. If such accuracy is obtained, the average cover of the drainage area must be at least 25 percentage points different from the upland to be considered different. Note that the remote sensing map of woody vegetation along the banks and in the nearby upland will be a complete census rather than a sample (thus no statistical test of samples is needed because the population value is estimated not the sample value) and an average will be calculated for the nearby upland stratum and drainage bank stratum. If the map does not meet the accuracy requirement, the field data will be statistically compared. The standard deviation of the field data will be calculated to determine how many additional transects need to be added, if any, to test for statistical differences of at least 0.25 (delta) using the sample size equation on p. A-11.

108. Appendix A, Section A4.4, Drainage Copper Sampling Design: first paragraph. More information is required regarding the collection of soil samples. What is the sample depth, will the samples be screened for size, where along the transect will the 3 samples be collected, how will the transect be oriented and where will the transect be located in relation to the stream channel?

Response: The appendix will be updated to include greater detail regarding the sample collection program. All soil samples will be collected from 0-6 inches bgs and sieved to <2 mm prior to analysis of pH and copper. The samples will be collected at the two ends and in the middle of each transect, which will be oriented parallel to the channel and located along the banks.

109. Appendix A, Section A4.4, Drainage Copper Sampling Design: first paragraph. Figure 4 shows a total of 6 locations to be sampled. 6 locations is a very low number to determine a 95UCL, let alone a spatially weighted UCL over 2 drainages which may or may not have the same copper concentrations due to topography or slope. Additional samples should be added to provide adequate data to define the 95UCL in both drainages.

In addition, samples should be collected in the drainage to the east (not named on the map) of the drainage currently shown with 2 sample locations. RI samples in that area showed elevated copper concentrations.

Response: Chino will include six additional samples and one additional drainage to allow for more accurate spatially weighted UCL across drainages to be calculated, including some locations in the un-named drainage to the east of the drainage currently shown.

110. Appendix A, Section A4.4, Copper Sampling Design: more information is required. Sample number, location etc. should be provided as it is in the other sections of this FSP.

Response: Text will be revised to include additional sampling design information in Table 6 of Appendix A.

111. Appendix A, Section A6.2: Samples are proposed over transects of multiple lengths with differing numbers of composite samples etc. None of that is addressed here; please review.

Response: Section A6.2 addresses soil specific AOC SOPs. SOP 22, listed in Section A6.2, discusses the compositing of 5 subsamples for upland soil samples. The drainage samples will not follow SOP 22 because Chino is concerned with the drainage banks which are less than 50 meters in width. Chino will composite the three bank samples taken along the 50 meter transect. These three samples will be taken at the zero (start), 25 (mid-point), and 50 (end) meter points along the transect.

The upland and drainage transects discussed in Section A4.4 are not covered by any AOC SOP. The transects, and corresponding samples, were specifically designed to fulfill data needs identified in the STSIU FS Proposal.

112. Appendix A, Section A6.2: 1 QC sample per every 10 samples should be collected. Please revise.

Response: Text will be revised to reflect that 1 QC sample will be collected for each 10 soil samples.

113. Appendix A, Section A.7: no sample handling procedures for the XRF samples are provided.

Response: The XRF sample handling procedures are described in Chino SOP 23, 23a, and USEPA Method 6200. Chino AOC SOP 23 and 23a are included as Attachment 1.

114. Appendix A, Section A.7: please provide a description of the compositing techniques.

Response: Text will be revised to include the following discussion on compositing for soil samples. "Each soil sample will be made up of five sub-samples taken on a 50 m by 50 m area."

115. Appendix A, Section A.7: three soil duplicates should be collected.

Response: Comment noted and text will be revised.

116. **Appendix A, Section A.8: this section does not provide information of sufficient detail to provide review. No criteria or guidelines for how and why different interpolation methods will be used are provided. Information similar to the decision tree provided in Figure 8 and discussed in the next section should be provided.**

Response: As discussed in Comment No. 83, the current data show that Kriging will provide a good semi-variogram and thus can be modeled. We will shorten this section on spatial interpolation of pCu to just using Kriging and supply the information supporting that choice. Copper has more options available as described in Figure 8 because of larger sample sizes per polygon available (data from 1995 to present and planned data collected in 2011 will be used).

117. **Appendix A, Section A.8.2: please provide a reference to appropriate guidance supporting the tests shown in Figure 8 or provide more detail to indicate why the tests shown in Figure 8 are appropriate for use in calculating spatially-weighted estimates of mean concentrations.**

Response: The paper "Developing Spatially Interpolated Surfaces and Estimating Uncertainty" (EPA-454/R-04-004, 2004) provides a general overview of spatial interpolation techniques, and a more detailed examination of Kriging models and parameterization.

There are two main factors in deciding between spatial estimation methods, frequency of detects and spatial autocorrelation. One significant advantage of Thiessen polygons over other methods is that Thiessen polygons rely on one and only one input sample, so non-detects can be carried through the process as non-detects. Therefore, sample sets with a low frequency of detect may be best estimated using Thiessen polygons, to avoid the necessity of a proxy value in an exposure point calculation (EPC), which may artificially inflate estimates. The Chino datasets so far rarely ever have non-detects, so this may not be an issue. A potential disadvantage of Thiessen polygons is that a single sample located in a sparsely-sampled area (exhibited in peaks of weighted concentration versus concentration) can have an overwhelming effect on an EPC.

Kriging depends on spatial autocorrelation, or the tendency of neighboring samples to have similar values, so datasets that do not exhibit spatial autocorrelation are best estimated with simpler methods requiring fewer assumptions, such as IDW (inverse distance weighting) or natural neighbor. Kriging also requires a semivariogram plot that indicates spatial structure in order to function well.

Screening can be used to decide if the use of a simpler, rather than more complicated, technique is best when they are unlikely to yield significantly different results.

118. **Appendix A, Section A.8.3: while NMED doesn't consider micro variability of pCu and/or habitat measures particularly important for wildlife populations, particularly for common species, if such analysis is to be completed, it should be completed at all sampling locations not just those that have pCu < 5. Micro variability can be just as important at locations where composite pCu is greater than 5.**

Response: Due to the requirement that sampling frequency be increased to evaluate micro-variability and that this issue of not of particular concern to NMED, this aspect of the sampling program will be removed from the appendix. Rangeland and wildlife habitat sampling will demonstrate quality of habitat that integrates the microscale variability.

119. Appendix A, Section A.8.4: references to this section should be provided in earlier sections of the document to aid the reader. In most cases, the same comments provided in the previous sections apply here.

Response: Comment noted and references to this section will be provided in earlier sections to aid the reader.

120. Appendix A, Tables: please add a table summarizing all samples to be collected.

Response: The proposal will be revised to include a table summarizing all samples to be collected.

121. Appendix A, Figure 1: please note in the legend, what the white highlighted numbers represent.

Response: Figure 1's legend will be revised to include – "Numeric values show represent rangeland polygons determined in DBS&A 1999."

122. Appendix B, Section B.1: no surveys appear to be planned to determine the presence of water in stream pools. This study should show the duration of flow within the channel, but does not seem to provide information related to areas that will contain water for longer periods. In an arid environment, these water holding areas are of high importance for the aquatic community and wildlife.

Response: The persistence of surface water in features which may provide aquatic habitat is being more specifically addressed as part of a hydrologic study being conducted in these same areas using NMED's Hydrology Protocol. This information will be incorporated into the FS process and analysis as appropriate. Although the focus of this study is not surface water persistence in areas where water may pool, the proposed data collection will provide some information relative to surface water persistence in areas addressed by this work plan. At eight (8) of the surface water monitoring locations, the depth and duration of water in the channel will be determined by measurement of water height using a pressure transducer and temperature probe. The depth of the water column at each location will be measured as pressure by the pressure transducer. The duration of water presence in the channel will be based on positive pressure readings by the pressure transducer. Water duration in channel locations equipped with pressure transducers will be verified by temperature measurements – diurnal temperature swings of surface water are damped compared with diurnal temperature swings of air. Water pressure and temperature will be recorded at 15 minute intervals until the probes are collected after the end of the monsoon season. At fourteen (14) additional surface water monitoring locations, duration of water presence will be measured by deploying temperature probes that will record water temperature at 15 minute intervals. Data recorded by these temperature probes will also be collected after the end of the monsoon season. Locations for deployment of pressure transducers and temperature probes will be biased towards surface water pools where water is expected to be present for a longer period of time.

123. Appendix B, Section B.2: regarding the third paragraph. Why is the BLM not being considered?

Response: The biotic ligand model (BLM) will be included in the evaluation of approaches for deriving site-specific metals criteria for surface water.

124. Appendix B, Section B.2: regarding last paragraph. No discussion is provided indicating how the data collected under this FSP will be used to allocate metals loading.

Response: Water depth data derived from the pressure transducers will be used along with channel geometry and channel roughness to estimate total volumetric flow of water for each storm event for which water samples are collected. The estimated flow from the pressure transducers and the water chemistry data will be used to calculate metals loading for the area of the basin located above each storm water sampling location. Existing soil and sediment concentration data will be evaluated to assess relative *potential loading contributions to surface water from soil versus from sediments. Basins with higher soil concentrations compared with sediment concentrations will be considered to have a higher potential loading from soil than from sediment. In addition, surface water concentration data for storm water samples will be compared with surface water samples previously collected between storm events. If surface water metals concentrations are higher in the between storm event samples compared with storm event samples, it can be inferred that loading from legacy sediments has a stronger influence on surface water concentrations than soil due to the longer contact time between water and sediment in channels versus between water and hillside soil.*

125. Appendix B, Section B.3: the title reference is incorrect.

Response: Title reference will be corrected to "Draft Groundwater Quality Pre-Feasibility Study Remedial Action Criteria for Drainage Sediments"

126. Appendix B, Section B.3: no discussion is provided indicating how the data collected under this FSP will be used to allocate metals loading.

Response: Comment noted. Please see response to Comment No. 124.

127. Appendix B, Section B.4: how were the locations with the greatest potential for exceeding benchmarks selected?

Response: Samples with the greatest potential for exceeding benchmarks were selected for storm water sampling based on all historical surface water metals concentrations for all STSIU surface water sampling locations. Sampling locations with the highest metals concentrations were selected for storm water sampling under the FSP.

128. Appendix B, Section B.4: the labels on Figure 1 should be changed to indicate whether the location is being used to monitor surface water quality. The temperature vs. temperature and pressure destinations are confusing since those are not discussed until later in the document.

Response: The legend in Figure 1 for locations designated with a green circle will be changed to "Stormwater Sampling and Temperature and Pressure Monitoring Location".

129. Appendix B, Section B.4: This section should specify how long after a sampling event the samples will be retrieved.

Response: Storm water samples will be retrieved from the samplers as soon as possible after storm events, based on road conditions and accessibility after the storm events. Ideally, samples will be collected within 24 to 48 hours after the storm event.

130. Appendix B, Section B.8: please check title for reference ARCADIS US, Inc. 2011.

Response: Please see response to Comment No. 125.

131. Appendix B, Table 1: table shows location SW05 but SW01 on Figure 1. Please check and revise as necessary.

Response: Table 1 will be revised by changing "SW05" to "SW01".

Table 1 (Response to Comment 83). Data used to estimate ratio of 0-1" depth data to 0-6" depth data.

Sample ID	pH 0-1 Inch	pH 0-6 Inch	Ratio of pH	Copper 0-1 Inch	Copper 0-6 Inch	Ratio of Copper in Site Soil	Ratio of Copper in Tailings Soils
FID 0				538	329	0.61	
FID 1				175	143	0.82	
FID 2				453	405	0.89	
FID 3				377	236	0.63	
FID 4				676	599	0.89	
FID 6				650	182	0.28	
FID 7				192	242	1.26	
FID 8	4.40	6.10	1.39	328	430		1.31
FID 10				1050	1020	0.97	
FID 12				5580	4260	0.76	
FID 13				1280	1970		1.54
FID 15				1530	1360	0.89	
FID 16				362	512		1.41
FID 17				9150	4680	0.51	
FID 18				215	326		1.52
FID 20				755	790		1.05
FID 21				153	131	0.86	
FID 22				347	285	0.82	
FID 23	3.80	3.70	0.97	168	252		1.50
FID 24				222	121	0.55	
FID 25				89	66	0.74	
FID 26				134	75	0.56	
FID 27				322	206	0.64	
FID 28				426	348	0.82	
FID 30				291	90	0.31	
FID 31				294	187	0.64	
FID 32				2250	2120	0.94	
FID 33				785	308	0.39	
FID 34				682	209	0.31	
FID 35				219	210	0.96	
FID 39				590	414	0.70	
FID 43	3.7	4.20	1.14	229	466	2.03	2.03
S77/SS147	7.78	7.86	1.01	379	267	0.70	
S76/SS144	7.59	7.78	1.03	449	278	0.62	
S75/SS140	7.62	7.75	1.02	1180	940	0.80	
S74/SS136	7.81	7.71	0.99	783	529	0.68	
S73/SS133	7.91	7.72	0.98	1500	1290	0.86	
SS131D/SS131S	5.19	4.76	0.92	454	444	0.98	
SS129D/SS129S	4.23	4.07	0.96	315	337	1.07	
S72/SS126	7.95	7.85	0.99	1400	1160	0.83	
SS124D/SS124S	7.66	7.56	0.99	1150	523	0.45	
SS125D/SS125S	4.83	5.22	1.08	398	166	0.42	
SS118D/SS118S	4.97	4.99	1.00	640	259	0.40	
SS119D/SS119S	6.42	6.10	0.95	338	125	0.37	
median	7.03	7.09	0.99	437.5	327.5	0.72	1.50
average	6.77729	6.78	1.03	897.681818	665.681818	0.74	1.48
sample size (n)	15	15	15	44	44	38	7
slope of Cu regression						0.61	1.41

Note: median ratio chosen as most valid--not influenced by outliers, median is close to 1.0 for pH, so no ratio adjustment req